Educational Background

The educational attainment of scientists and engineers differs among racial or ethnic groups. Black scientists and engineers, on average, have a lower level of education than scientists and engineers of other racial or ethnic groups. Black scientists and engineers are more likely than white, Hispanic, or Asian scientists and engineers to have a bachelor's degree as the terminal degree: 64 percent of black scientists and engineers in the U.S. workforce have a bachelor's degree as the highest degree compared to 57 percent of all scientists and engineers in 1997. (See appendix table 3-10.)

Labor Force Participation, Employment, and Unemployment

Labor force participation rates vary by race or ethnicity. Minority scientists and engineers were more likely than whites to be in the labor force, that is, employed or looking for employment. Between 91 and 95 percent of black, Asian, Hispanic, and American Indian scientists and engineers were in the labor force in 1997, compared with 87 percent of white scientists and engineers. (See appendix table 3-13.) Age differences are part of the explanation. White scientists and engineers are older, on average, than scientists and engineers of other racial or ethnic groups: 25 percent of white scientists and engineers were age 50 or older in 1997, compared with between 15 and 18 percent of Asians, blacks, and Hispanics. Among those in similar age groups, the labor force participation rates of white and minority scientists and engineers are similar. (See NSF 1999b.)

Although minorities, for the most part, are less likely to be out of the labor force, among those who are in the labor force, minorities are more likely to be unemployed. In 1997, the unemployment rate of white scientists and engineers was significantly lower than that of other racial or ethnic groups. The unemployment rate for whites was 1.4 percent, compared with 2.6 percent for Hispanics, 1.9 percent for blacks, and 2.0 percent for Asians. The differences in unemployment rates were evident within fields of S&E, as well as for S&E as a whole. For example, the unemployment rate for white engineers was 1.6 percent; for black and Asian engineers, it was 2.5 percent and 2.1 percent, respectively.

Sectors of Employment

Racial or ethnic groups differ in employment sector, partly because of differences in field of employment. Among employed scientists and engineers in 1997, 57 percent of black, 58 percent of Hispanic, and 50 percent of American Indian, compared with 63 percent of white and 67 percent of Asian scientists and engineers were employed in for-profit business or industry. Blacks and American Indians are concentrated in the social sciences, which are less likely to offer employment in business or industry, and are underrepresented in engineering, which is more likely to offer employment in business or industry. Asians, on the other hand, are overrepresented in engineering and thus are more likely to be employed by private for-profit employers.

Black, Hispanic, and American Indian scientists and engineers are also more likely than other groups to be employed in government (Federal, state, or local): 22 percent of black, 16 percent of Hispanic, and 19 percent of American Indian scientists and engineers were employed in government in 1997, compared with 13 percent of white and 12 percent of Asian scientists and engineers.

Salaries

Salaries for scientists and engineers vary somewhat among racial or ethnic groups. Among all scientists and engineers, the median salaries by racial or ethnic group are $55,000 for whites and Asians, $48,000 for blacks, $50,000 for Hispanics, and $46,000 for American Indians. (See figure 3-11 and appendix table 3-16.) Within fields and age categories, median salaries of scientists and engineers by race or ethnicity are not dramatically different and do not follow a consistent pattern. For example, the median salary of engineers with bachelor's degrees who are between the ages of 20 and 29 ranged from $40,000 for Hispanics to $44,000 for Asians. Among those between the ages of 40 and 49, the median salary ranged from $55,000 for Hispanics to $62,600 for whites. Looking at time in the work force, the median salary of engineers with bachelor's degrees in 1997 who had received their degree within the last five years was $40,000 for all ethnicities. (See appendix table 3-17.) Among those who had received their degrees 20–24 years before, the median salary was approximately $65,000 for all ethnicities.

Labor Market Conditions for Recent S&E Degree-Holders

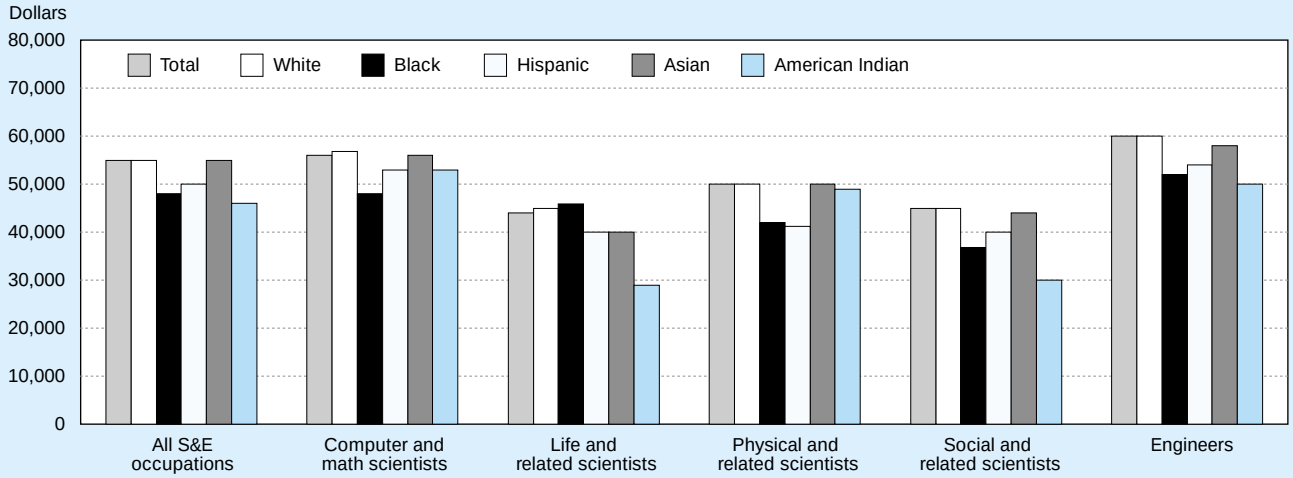
Bachelor's and Master's Degree Recipients[16]

Recent S&E bachelor's and master's degree recipients form a key component of the Nation's S&E workforce; they account for almost half the annual inflow to the S&E labor market. The career choices of recent graduates and their entry into the labor market affect the balance between the supply of and demand for scientists and engineers in the United States. Analysis of the workforce status and other characteristics of recent S&E graduates can yield valuable labor market information.

This section provides several labor market measures that offer useful insights into the overall supply and demand conditions for recent S&E graduates in the United States. Among these measures are median annual salaries, unemployment rates, and in-field employment rates.

[16]Data for this section are taken from the 1997 National Survey of Recent College Graduates. This survey collected information on the 1997 workforce-other status of 1995 and 1996 bachelor's and master's degree recipients in S&E fields. Surveys of recent S&E graduates have been conducted biennially for NSF since 1978. For information on standard errors associated with survey data, see NSF (in press, a).

Figure 3-11.
Median annual salaries of scientists and engineers, by broad occupation and race/ethnicity: 1997



NOTE: Individuals are characterized as scientists or engineers based on their current occupation.

See appendix table 3-16.

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Median Annual Salaries

In 1997, the highest median annual salaries for recent full-time employed graduates with bachelor's degrees in the sciences went to those with degrees in computer and information sciences ($37,700), and the highest salaries among those with degrees in engineering went to those with degrees in electrical, electronics, computer, and communications engineering ($40,500). (See appendix table 3-18.)

The same pattern was true among recent graduates with master's degrees. The highest median annual salaries went to graduates with master's degrees in computer and information sciences ($51,200) and electronics, computer, and communications engineering ($55,000).

School versus Employment

Approximately one-fifth of 1995 and 1996 bachelor's and master's graduates were enrolled in graduate school on a full-time basis in 1997. Students who had majored in the physical and related sciences and the life and related sciences were more likely to be in graduate school as full-time students than were graduates with degrees in computer and information sciences or engineering. (See appendix table 3-18.)

Employment Related to Field of Degree

Although individuals use college degrees to enter a wide variety of career paths, the extent to which their employment is related to their degrees may be one indicator of the vocational relevance of a degree. Across all fields of S&E in 1997, 70.4 percent of recent bachelor's degree graduates and 91.4 percent of recent master's degree graduates said their jobs were related to their field of degree (appendix tables 3-3 and 3-4). At the bachelor's level, employment related to field of degree for recent S&E graduates varied from 58.8 percent in the social sciences to 92.9 percent in computer sciences and 89.3 percent in engineering. At the master's degree level, there is much less variation by field of degree—ranging from 87.6 percent of recent master's degree graduates in social sciences saying their jobs are related to their degrees, to 97.9 percent of recent computer sciences master's degree graduates.

Employment Sectors

The private, for-profit sector is by far the largest employer of recent bachelor's and master's S&E degree recipients. (See text table 3-5.) In 1997, 66 percent of bachelor's degree recipients and 59 percent of master's degree recipients were employed in private, for-profit companies. The academic sector has been the second largest employer of recent S&E graduates. Master's degree recipients were more likely to be employed in four-year colleges and universities (9 percent) than were bachelor's degree recipients (5 percent). The Federal sector employed only 7 percent of S&E master's degree recipients and 4 percent of S&E bachelor's degree recipients in 1997. Engineering graduates are more likely to find employment in the Federal sector than science graduates. Other sectors employing small numbers of recent S&E graduates include educational institutions other than four-year colleges and universities, nonprofit organizations, and state and local government agencies.

Recent Doctoral Degree Recipients

Concerns about the labor market for workers with doctorates in S&E often focus on recent Ph.D. recipients entering the labor market and attempting to begin a career. Although the vast majority of S&E Ph.D. recipients find work that is related to their degrees, there is concern that fewer opportunities may make doctoral level science careers less desirable.

Text table 3–5.
Percentage of employed 1995 and 1996 S&E bachelor's and master's degree recipients, by sector of employment and field of degree: 1997

Degree and field [a]	Total employed (thousands)	Sector of employment [b]: Educational: 4-year college and university	Educational: Other educational institutions	Noneducational institutions: Private for-profit company	Noneducational institutions: Self-employed	Noneducational institutions: Nonprofit organization	Noneducational institutions: Federal Government	Noneducational institutions: State or local government
		Percentage distribution						
Bachelor's recipients								
S&E	524.4	5	9	66	7	2	4	7
All sciences	428.4	6	11	62	8	2	3	8
All engineering	96.0	2	2	85	1	1	7	3
Master's recipients								
S&E	113.6	9	10	59	7	2	7	6
All sciences	74.4	12	15	49	10	2	6	6
All engineering	39.2	5	<1	79	1	1	9	4

[a] For graduates with more than one eligible degree at the same level (bachelor's or master's), the degree for which the graduate was sampled was used.

[b] This is the sector of employment in which the respondent was working on his or her primary job held on April 15, 1997. In this categorization, those working in four-year colleges and universities or university-affiliated medical schools or research organizations were classified as employed in the "four-year college and university" sector. Those working in elementary, middle, secondary, or two-year colleges or other educational institutions were categorized in the group "other educational." Those reporting that they were self-employed but in an incorporated business were classified in the private, for-profit sector.

NOTE: Details may not add to totals because of rounding. Percentages were calculated on unrounded data.

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), *National Survey of Recent College Graduates, 1997.*

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Since the 1950s, the Federal Government has actively encouraged graduate training in science through a number of mechanisms. Real or perceived labor market difficulties for new Ph.D. scientists and engineers, however, could have various adverse effects on the health of scientific research in the United States. If labor market difficulties are real but temporary, promising students may be discouraged from pursuing degrees in S&E fields. Eventually, this circumstance could reduce the ability of industry, academia, and government to perform R&D, transfer knowledge, or perform many of the other functions of scientists in the modern economy. If labor market difficulties are long term, restructuring may need to take place within graduate education both to maintain high-quality research and to prepare students better for a wider range of career options. In either case, when much high-level human capital goes unused, society loses opportunities for new knowledge and economic advancement, and individuals feel frustrated in their careers.

Most individuals who complete an S&E doctorate are looking for more than just steady employment at a good salary. Their technical and problem-solving skills make them highly employable, but the opportunity to do the type of work they want and for which they have been trained is important to them. For that reason, no single measure can describe well the S&E labor market. Some of the available labor market indicators are discussed below.[17]

Aggregate measures of labor market conditions changed only slightly for recent doctorate recipients in S&E (defined here as those one to three years after their degree). Unemployment fell from 1.9 percent for a similar graduation cohort in 1995 to 1.5 percent in 1997. (See text table 3-6.) At the same time, the proportion of recent Ph.D. recipients reporting that they were either working outside their field because a job in their field was not available, or that they were involuntarily working part-time, rose slightly from 4.3 percent to 4.5 percent. These aggregate numbers mask a number of changes—both positive and negative—in a number of individual disciplines. In addition, in many fields the involuntarily out of field (IOF) and unemployment rates moved in opposite directions. In many ways, whether highly skilled individuals who are unable to get the type of employment they desire become unemployed or accept employment outside their field, may reflect the type of expectations they have of the labor market.

Unemployment Rates

Even compared to relatively good labor market conditions in the general economy, the 1.5 percent unemployment rate for recent S&E Ph.D. recipients is very low—the April 1997 unemployment rate for all civilian workers was 5.0 percent. (See the sidebar, "Data on Recent Ph.D. Recipients in Professional Society Data.")[18] In 1995, recent graduates in several

[17] Data on recent Ph.D. recipients presented here comes from the NSF/SRS 1993, 1995, and 1997 Survey of Doctorate Recipients, a component of the SESTAT data file that contains a 1/11 sample of S&E Ph.D. holders from U.S. schools. Ph.D. holders from foreign institutions were not included.

[18] People are said to be unemployed if they were not employed during the week of April 15, 1997, and had either looked for work during the preceding four weeks or were on layoff from a job. Although slightly different questions are used in the SESTAT surveys, this closely approximates the definition of unemployment used by the Bureau of Labor Statistics.

Text table 3–6.
Labor market rates for recent Ph.D. recipients: 1995 and 1997

	1–3 years after Ph.D.			
	Unemployment rate		Involuntary out-of-field rate	
Field	1995	1997	1995	1997
All S&E	1.9	1.5	4.3	4.5
Engineering	1.7	1.0	3.7	3.6
Chemical engineering	4.4	1.7	3.6	5.8
Civil engineering	1.2	0.0	1.1	5.5
Electrical engineering	0.9	0.6	3.1	3.2
Mechanical engineering	2.8	0.5	4.8	2.7
Other engineering	1.6	1.6	5.2	3.0
Life sciences	2.0	1.7	2.6	2.6
Agriculture	1.1	2.2	2.2	7.3
Biological sciences	2.0	1.5	2.7	2.2
Computer/math sciences	2.6	0.6	6.1	6.5
Computer sciences	1.1	0.7	2.7	2.1
Mathematical sciences	3.9	0.6	9.2	11.0
Physical sciences	2.4	2.1	5.3	6.9
Chemistry	2.2	3.5	4.1	3.3
Geosciences	1.7	1.0	6.8	6.3
Physics/astronomy	3.0	0.7	6.7	12.2
Social sciences	1.4	1.6	5.5	5.4
Economics	1.4	0.9	2.6	5.2
Political science	2.4	2.6	11.2	7.9
Psychology	0.5	1.2	3.8	3.8
Sociology/anthropology	3.1	2.5	9.0	7.7
Other social sciences	2.5	2.5	6.8	7.1

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), 1995 and 1997 Survey of Doctorate Recipients.

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Data on Recent Ph.D. Recipients in Professional Society Data

In 1998, data from surveys of new Ph.D. recipients for 1996–97 conducted by 13 S&E professional societies on 14 different disciplines were coordinated by the Commission on Professionals in Science and Technology. A common set of core questions was used in each society's poll of its own doctoral graduates to allow for collection of comparable career-related data. One of these common data elements, the unemployment rate is shown in text table 3-7. Unemployment ranged from 1.8 percent for recent physics Ph.D. recipients to 7.0 percent for recent Ph.D. recipients in political science.

Text table 3–7.
Unemployment rates for recent Ph.D. recipients reported in professional society surveys

Field	1995–96 Ph.D. recipients in 1997	1996–97 Ph.D. recipients in 1998
Biochemistry and molecular biology	NA	4.0
Chemistry	4	4.6
Chemical engineering	2	3.2
Computer science	2	2.4
Earth and space science	3	3.9
Economics	NA	2.3
Engineering	NA	2.7
Mathematics	5	2.4
Microbiology	NA	2.2
Physics	3	1.8
Physiology	NA	2.7
Political science	NA	7.0
Sociology	NA	1.9

NA = not available.

NOTE: Data for 1997 and 1998 were reported with different numbers of significant digits.

SOURCE: Commission on Professionals in Science and Technology.

Ph.D. disciplines had unemployment rates above 3 percent—still low, but unusually high for a highly skilled group. Between 1995 and 1997, unemployment rates fell for recent Ph.D. recipients in most disciplines, but increased in a few. The largest increase was in chemistry, where the unemployment rate for recent Ph.D. recipients rose from 2.2 to 3.5 percent—also making chemistry the field with the greatest unemployment rate for recent Ph.D. recipients. In 1997 unemployment rates of less than 1 percent were found for recent Ph.D. recipients

in civil engineering (0.0 percent),[19] mechanical engineering (0.5 percent), electrical engineering (0.6 percent), mathematical sciences (0.6 percent), computer sciences (0.7 percent), physics-astronomy (0.7 percent), and economics (0.9 percent).

Involuntarily Working Outside Field

Another 4.5 percent of recent S&E Ph.D. recipients in the labor force reported that they could not find full-time employment (if they wished full-time employment) that was "closely related" or "somewhat related" to their degrees.[20] Although this is a more subjective measure than unemployment rates, it often provides a more sensitive indicator of labor market difficulties for a highly educated and employable population. It is best used, however, along with the unemployment rate as measures of two different forms of labor market distress.

[19]An unemployment rate of 0.0 does not mean that no one in that field was unemployed, but that the estimated rate from NSF's sample survey was less than 0.05 percent.

[20]People were considered as working involuntarily outside their field if they said their jobs were not related to their degrees and they said that one reason was because no job in their field was available, or if they were part-time and said that the only reason was because a full-time job was not available. The involuntarily out of field rate (IOF) is calculated as the percentage that such individuals are of those in the labor force.

The highest IOF rates in 1997 were found for recent Ph.D. graduates in physics-astronomy (12.2 percent) and in mathematical sciences (11.0 percent). These two fields also had among the lowest unemployment rates, although in physics-astronomy the increase in the IOF rate from 1995 to 1997 was much greater than the decrease in unemployment. The lowest IOF rates were found in computer sciences (2.1 percent) and the biological sciences (2.2 percent).

Tenure-Track Positions

Most S&E Ph.D. recipients do not ultimately work in academia—in most S&E fields this has been true for several decades. (Also see chapter 6, "Academic Research and Development: Financial and Personnel Resources, Support for Graduate Education, and Outputs.") In 1997, of S&E Ph.D. recipients four to six years after receipt of their degrees, only 22.9 percent were in tenure track or tenured positions at four-year institutions of higher education. (See text table 3-8.) Across fields, tenure-program academic employment four to six years after Ph.D. ranged from 11.9 percent in chemical engineering to 51.2 percent in sociology-anthropology. For Ph.D. recipients one to three years after their degrees, only 16.0 percent were in tenure programs, but this reflects the

Text table 3–8.
Percentage holding tenure and tenure-track appointments at four-year institutions: comparison of recent Ph.D. recipients: 1993, 1995, and 1997

	Recent Ph.D. recipients, tenured or tenure-track at four-year institutions					
	Years since receipt of Ph.D.					
	1995		1995		1997	
Field	1–3 years	4–6 years	1–3 years	4–6 years	1–3 years	4–6 years
All S&E	18.4	26.6	15.6	26.3	16.0	22.9
Engineering	16.0	24.6	12.7	20.5	10.9	17.8
Chemical engineering	8.1	14.0	6.1	5.5	2.8	11.9
Civil engineering	24.7	27.1	25.6	29.3	24.8	23.0
Electrical engineering	17.6	26.9	10.6	21.5	8.3	16.6
Mechanical engineering	13.5	29.5	14.5	25.4	9.1	14.4
Other engineering	13.9	21.3	10.5	17.3	12.5	18.5
Life sciences	12.6	24.8	12.6	24.0	12.6	22.4
Agriculture	15.6	27.0	13.5	25.0	21.6	24.3
Biological sciences	12.1	24.8	12.5	23.7	11.7	22.3
Computer/math sciences	39.7	54.1	34.8	47.3	27.9	37.8
Computer sciences	37.1	51.5	34.3	41.5	28.4	33.3
Mathematical sciences	41.8	56.0	35.2	52.6	27.3	41.2
Physical sciences	9.7	18.2	7.3	17.2	7.6	17.6
Chemistry	7.7	16.3	6.8	14.6	6.4	16.8
Geosciences	12.7	26.2	10.8	29.7	18.4	29.5
Physics/astronomy	12.0	17.7	5.8	15.2	4.6	15.0
Social sciences	26.4	29.2	21.5	33.6	25.1	27.1
Economics	46.6	48.6	41.7	54.5	34.8	48.0
Political science	53.9	47.1	29.5	66.1	40.5	39.0
Psychology	12.7	15.5	12.7	19.4	13.0	15.8
Sociology/anthropology	37.9	46.9	30.8	48.3	35.3	51.2
Other social sciences	37.4	48.8	27.3	41.4	39.7	33.5

SOURCE: National Science Foundation, Division of Science Resource Studies (NSF/SRS), 1993, 1995, and 1997 Survey of Doctorate Recipients.

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increasing use of postdoctoral appointments (or postdocs) by recent Ph.D. recipients in many fields.

Although academia must be considered just one possible sector of employment for S&E Ph.D. recipients, the availability of tenure-track positions is an important aspect of the job market for those who do seek academic careers. The rate of tenure-program employment for those four to six years since receipt of Ph.D. fell from 26.6 percent in 1993 to 22.9 percent in 1997, which reflects both job opportunities in academia and alternate opportunities for employment. For example, one of the largest declines in tenure-program employment occurred in computer sciences (from 51.5 percent in 1993 to 33.3 percent in 1997) where other measures of labor market distress are low and organizations of computer science departments report difficulties recruiting faculty.[21] The attractiveness of other employment may also be an explanation for drops in tenure-program rates in several engineering disciplines. The attractiveness of alternate employment, however, is a less likely explanation for the smaller drops in tenure-program employment rates in fields with other measures of distress, such as physics and mathematical sciences (both of which have large IOF rates) and the biological sciences (which have low unemployment and IOF rates, but have other indications of labor market distress).

Relationship Between 1997 Occupation and Field of Degree

By a strict definition of occupational titles, 15.0 percent of employed recent Ph.D. recipients were in occupations outside S&E, often with administrative or management functions. When asked how related their jobs were to their highest degree, only a small proportion of recent Ph.D. recipients in non-S&E occupations said that their jobs were unrelated to their degrees. (See text table 3-9.) By field, these respondents ranged from 1.4 percent of recent psychology and computer science Ph.D. graduates to 6.3 percent of recent Ph.D. graduates in mathematical sciences.

Salary for Recent S&E Ph.D. Recipients

Across all fields of degree, the median salary for recent S&E Ph.D. recipients was $41,000, a increase of 2.5 percent from 1995. By field, this ranges from a low of $32,000 in the biological sciences to a high of $68,000 in electrical engineering. Text table 3-10 shows the distribution of salaries for recent Ph.D. recipients by field of degree. For all Ph.D. recipients, those at the top 10 percent of the salary distribution (the 90th percentile) were paid $71,000. (See text table 3-10.) The 90th percentile salary varied by field from a low of $55,000 for sociology-anthropology to a high of $86,000 for computer science Ph.D. recipients. At the 10th percentile, representing the lowest-paid 10 percent among each field, salaries ranged from $16,000 for sociology-anthropology Ph.D. recipients to $45,000 for industrial engineering.

Salaries for recent S&E Ph.D. recipients by sector of employment are given in text table 3-11. The median salary for a postdoc one to three years after receipt of degree was $28,000—about half the median for a recent Ph.D. recipient working for a private company ($60,000). Many of the salary differentials between different S&E fields are narrower when examined within sector of employment. For those in tenure-track positions, median salaries ranged from about $37,000 in mathematical sciences to $50,000 for computer S&E. At private for-profit companies, median salaries ranged from $43,000 for psychology to $72,000 for computer science.

Changes in median salaries for recent (defined here as one to five years after receipt of degree) bachelor's, master's, and Ph.D. graduates are shown in text table 3-12. Across all S&E fields, median salaries for Ph.D. recipients rose by just 2.3 percent from 1995 to 1997—compared with 11.1 percent for bachelor's and 10.0 percent for master's degree graduates. To a considerable extent however, the median salary across all fields of Ph.D. was held down by relatively more rapid growth in Ph.D.

[21] See Freeman and Aspray (1997).

Text table 3–9.
Recent Ph.D. scientists and engineers, by field of degree and relationship between field of study and occupation: 1997
(Percent)

Field	Employed Recent Ph.D.				
	Total	Same field	Other S&E	Related non-S&E	Nonrelated, Non-S&E
All S&E	100.0	71.9	13.1	12.3	2.8
Computer sciences	100.0	83.4	3.0	12.2	1.4
Engineering	100.0	75.0	17.8	5.5	1.7
Life sciences	100.0	71.8	6.3	19.2	2.7
Mathematical sciences	100.0	70.6	14.9	8.2	6.3
Other social sciences.	100.0	67.7	5.2	22.1	4.9
Physical sciences	100.0	72.0	20.5	4.5	3.0
Psychology	100.0	68.0	21.9	8.7	1.4

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), 1997 Survey of Doctorate Recipients.

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Text table 3–10.
Salary distribution for recent Ph.D. recipients: 1997

Field	Percentile				
	10th	25th	Median	75th	90th
Total recent S&E Ph.D.	$24,000	$30,000	$41,000	$58,000	$71,000
Computer/math, total	32,000	37,500	50,000	68,000	80,000
Computer sciences	37,500	46,000	60,000	72,250	86,000
Mathematical sciences	30,000	34,000	40,000	52,500	70,000
Life sciences, total	22,000	26,000	32,300	45,600	60,000
Agriculture	20,500	28,000	38,900	49,000	58,000
Biological sciences	22,000	25,600	32,000	45,000	60,000
Health/medical	25,000	35,000	40,500	51,500	61,000
Physical sciences, total	24,000	31,000	41,500	58,000	67,000
Chemistry	22,000	27,000	40,000	58,000	65,000
Geosciences	29,000	33,000	39,860	48,000	63,000
Physics/astronony	27,150	35,000	43,070	60,000	70,000
Social sciences, total	20,000	31,000	40,000	49,000	64,000
Economics	30,000	43,000	50,000	64,500	80,000
Political science	21,000	33,000	40,000	47,000	65,000
Psychology	20,000	30,000	38,000	46,700	60,000
Sociology/anthropology	16,000	30,000	37,000	43,495	55,000
Other social sciences	20,000	33,500	39,000	46,500	61,000
Engineering, total	35,000	49,000	60,000	70,000	80,000
Aerospace engineering	39,000	50,000	56,000	65,000	70,000
Chemical engineering	30,000	49,000	60,000	68,000	76,100
Civil engineering	31,500	40,000	48,000	56,000	72,000
Electrical engineering	44,000	55,760	68,000	75,000	85,000
Industrial engineering	45,000	52,500	60,000	70,000	80,000
Mechanical engineering	40,000	48,800	58,540	69,000	76,000
Other engineering	30,000	43,000	55,000	65,000	74,300

SOURCE: National Science Foundation, Division of Science Resource Studies (NSF/SRS), 1993, 1995, and 1997 Survey of Doctorate Recipients.

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Text table 3–11.
Median salaries for recent U.S. Ph.D. recipients, by sector of employment: 1997

Field	Total	Private/ noneducational	Government	Tenure-track at four-year institution	Postdoc	Other educational
Total	$41,000	$60,000	$53,000	$42,000	$28,000	$36,000
Computer sciences	60,000	72,000	—	50,000	—	—
Engineering	60,000	65,000	60,000	50,000	35,000	48,000
Life sciences	32,300	55,000	50,000	42,300	27,000	35,000
Math sciences	40,000	60,000	—	37,150	—	35,000
Social sciences (other than psychology)	40,000	53,000	52,400	40,000	30,500	35,000
Physical sciences	41,500	60,000	57,300	39,000	32,000	35,000
Psychology	38,000	43,000	45,000	38,000	26,700	36,000

— = Fewer than 50 cases.

SOURCE: National Science Foundation, Division of Science Resource Studies (NSF/SRS), 1993, 1995, and 1997 Survey of Doctorate Recipients.

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Text table 3–12.
Change in median salaries for S&E graduates one to five years after degree: percentage change between 1995 and 1997

Field	Bachelor's	Master's	Ph.D.
All S&E Fields	11.1	10.0	2.3
Engineering	8.1	6.4	7.1
Chemical engineering	2.4	6.4	1.6
Civil engineering	2.9	8.0	–3.8
Electrical engineering	13.2	10.0	15.8
Mechanical engineering	5.3	11.1	9.1
Life sciences	4.2	6.7	–1.7
Agricultural sciences	4.2	6.9	0.0
Biological sciences	6.4	6.7	6.6
Computer/math sciences	12.8	12.4	14.6
Computer sciences	16.0	12.5	11.7
Mathematical sciences	8.9	14.3	5.3
Physical sciences	10.1	2.8	9.3
Chemistry	-3.6	0.0	2.0
Geoscience	16.7	0.0	2.5
Physics	41.7	20.0	17.5
Social sciences	8.3	5.8	5.0
Economics	10.0	20.0	10.0
Political science	12.0	11.8	6.2
Psychology	14.3	4.3	0.0
Sociology/anthropology	9.1	1.8	–2.7

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), 1995 and 1997 SESTAT data file.

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Text table 3–13.
Percentage of recent S&E graduates who say they are "not at all likely" to choose the same field of study if they could do it over again (one to five years after degree)

Field	Bachelor's	Master's	Ph.D.
All S&E fields	20.2	12.6	16.6
Engineering	11.3	12.6	14.8
Chemical engineering	9.5	13.1	13.0
Civil engineering	14.2	16.6	20.9
Electrical engineering	8.3	6.5	9.8
Mechanical engineering	10.2	16.6	16.5
Life sciences	16.8	13.9	18.3
Agricultural sciences	20.7	18.4	20.7
Biological sciences	16.0	14.0	18.2
Computer/math sciences	8.9	6.6	14.5
Computer sciences	6.8	5.3	6.8
Mathematical sciences	12.0	10.3	22.4
Physical sciences	16.1	18.6	23.3
Chemistry	15.7	27.2	23.9
Geoscience	25.2	12.5	20.3
Physics	9.7	17.0	24.4
Social sciences	27.3	14.3	12.5
Economics	23.7	11.8	12.6
Political science	25.5	19.6	13.3
Psychology	28.4	13.7	10.8
Sociology/anthropology	31.2	15.7	15.5

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS),1995 and 1997 SESTAT data file.

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production in lower-paying fields, such as the biological and social sciences. Much larger increases were found in most individual disciplines, including double-digit increases in physics (17.5 percent), electrical engineering (15.8 percent), computer sciences (11.7 percent), and economics (10.0 percent). Declines in median salaries were observed in civil engineering (–3.8 percent) and sociology-anthropology (–2.7 percent).

Happiness with Choice of Field of Study

One indicator of the quality of employment available to recent graduates is simply their answer to this question: If you had the chance to do it over again, how likely is it that you would choose the same field of study for your highest degree? When this was asked of those with S&E degrees received 1–5 years after their previous degree, 16.6 percent of Ph.D. recipients said they were "not at all likely" as compared with 20.2 percent of those with S&E bachelor's degrees. (See text table 3-13.) This regret of field choice is lowest for recent Ph.D. recipients in computer sciences (6.8 percent) and electrical engineering (9.8 percent), and in the social sciences (12.5 percent). It is greatest in physics (24.4 percent), chemistry (23.9 percent), and mathematical sciences (22.4 percent).

Postdoctoral Appointments

A postdoctoral appointment (or postdoc) is defined here as a temporary position awarded in academia, industry, or government primarily for the purpose of gaining additional training in research. This definition has been used in the Survey of Doctorate Recipients to ask respondents about current and past postdoctorate positions they have held.[22] Data and analyses on postdoctorates are often examined in relation to recent Ph.D. labor market issues. In addition to gaining more training, recent Ph.D. recipients may accept a temporary, usually lower-paying, postdoctorate position because a more permanent job in their field is not available. The increasing use of postdocs has been a focal point of discussions about many inter-related topics—the early career paths for new Ph.D. scientists, the vocational adequacy of Ph.D. programs, and the labor market expectations of new Ph.D. recipients.[23]

Science & Engineering Indicators – 1998 included an analysis of a one-time postdoctorate module in the 1995 Survey of Doctorate Recipients that showed a slow increase the use of postdocs in many disciplines over time.[24] In addition, in physics and the biological sciences, the fields with the heavi-

[22]It is clear, however, that the exact use of the term "postdoctorate" differs among academic disciplines, among different universities, and among the different sectors that employ postdoctorates. It is likely that these differences in labeling affected self-reporting of postdoctorate status on the Survey of Doctorate Recipients.

[23]A recent overview of issues related to postdocs was published in *Science*, September 3, 1999, "Postdocs: Working for Respect."

[24]This was measured cross-sectionally by looking at the percentage of each graduation cohort that reported ever being in a postdoc position.

Text table 3-14.
Primary reason for taking current postdoc: 1997
(Percent)

Field	Additional training in Ph.D. field	Training outside of Ph.D. field	Postdoc generally expected in field	Work with a particular person or place	Other employment not available	Other
Biological sciences	20.1	14.7	28.1	18.7	13.5	5.0
Chemistry	21.0	13.5	25.3	14.1	25.3	7.7
Engineering	18.4	12.9	7.0	20.7	23.1	17.9
Geoscience	29.4	3.5	18.3	7.6	29.3	11.9
Physics	13.7	8.4	34.4	16.7	19.1	7.6
Psychology	29.1	9.7	21.3	19.4	12.4	8.1
All S&E fields	20.0	13.325	23.7	18.3	17.2	7.5

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), Survey of Doctorate Recipients, 1997.

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est use of postdocs, median time in postdoc positions extended well beyond the one to two years found in most other fields.

Data from 1997 show a small decline in the percentage of all recent S&E Ph.D. recipients entering postdoc positions—from 32.7 percent of 1994 graduates in 1995 to 30.7 percent of 1996 graduates in 1997. At the same time, however, Ph.D. recipients in earlier graduation cohorts in these two fields show a similar propensity to be in postdocs as those with the same years since degree in 1995. Speculatively, something like this might be observed if new graduates were the most affected by improvements in labor market conditions. In fields other than physics or biological sciences, the postdoc rate one year after degree fell only slightly, from 21.2 percent in 1995 to 19.9 percent in 1997.

Reasons for Taking a Postdoc

Postdocs in 1997 were asked to provide reasons they were in their current postdoctoral appointment—the distribution of "primary reasons" given is shown in text table 3-14. Across all fields of degree, 17.2 percent gave "other employment not available" as the primary reason they were in a postdoc. Most respondents gave as primary reasons that a postdoc was generally expected for a career in their field (23.7 percent), that they were seeking additional training either in or outside of their Ph.D. field (20.0 and 13.3 percent), or other reasons more consistent with the stated training and apprenticeship functions of postdocs.[25]

Postdoc Transitions: What Were 1995 Postdocs Doing in 1997?

Of those in postdoctorate positions in April 1995, 38.0 percent were still in a postdoctorate position in April 1997. (See text table 3-15.) This is a small reduction from the 41.6 percent of 1993 postdocs that were still postdocs in 1995. (See *Science and Engineering Indicators 1998*.) Only 16.5 percent had moved from a postdoctorate to a tenure-track position at a four-year educational institution (up from 12.1 percent in 1995); 18.3 percent found other employment at an educational institution; 18.0 percent were at a for-profit firm;

[25]Respondents may well have defined their field in far narrower terms than reported here. Hence "training out of field" may refer to a biologist doing postdoc research on a topic different from their dissertation as opposed to doing a postdoc in chemistry.

Text table 3–15.
What were 1995 postdocs doing in 1997?
(Percent)

Field	Postdoc	Tenure-track at four-year institution	Other education	For-profit	Nonprofit / government	Unemployed
Biological sciences	49.3	14.0	17.9	12.4	5.4	1.0
Chemistry	23.1	16.8	20.4	26.5	6.1	7.1
Engineering	26.8	12.9	10.4	38.4	9.1	2.4
Physics	33.1	16.6	16.5	23.2	10.4	0.1
Psychology	17.2	14.8	23.1	27.1	17.7	0.0
All S&E fields	38.0	16.5	18.3	18.0	7.7	1.5

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), merged 1995 and 1997 file from NSF's Survey of Doctorate Recipients.

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7.7 percent were employed at a nonprofit institution or government; and 1.5 percent were unemployed.

No information is available on the career intentions of those in postdoc positions, but it is often assumed that a postdoc is most valued by academic departments at research universities. More postdocs, however, in each field transition to for-profit employment than obtain tenure-track positions—and many tenure-track positions are at schools where a research record obtained through a postdoc appointment may not be of central importance.

Age and Retirement

The size of the S&E labor force, its productivity, and opportunities for new S&E workers are all greatly affected by the age distribution and retirement patterns of the S&E labor force. For many decades, rapid increases in new entries to the S&E labor force led to a relatively young S&E labor force with only a small percentage near traditional retirement ages. This general picture is rapidly changing as the large number of individuals who earned S&E degrees in the late 1960s and early 1970s are moving into what is likely to be the latter part of their careers.

The possible effects of age distribution on scientific productivity are controversial. Increasing average ages may mean increased levels of experience and productivity among scientific workers. Others have argued that it can reduce the opportunities for younger scientists to perform independent work. Indeed, in many fields there is scientific folklore and some actual evidence indicate that the most creative research comes from the young. The ongoing research in cognitive aspects of aging and the sociology of science is relevant to this debate, but will not be reviewed here.[26]

Age

Age distributions for scientists and engineers in the labor force are affected by many factors—net immigration, morbidity, and mortality—but most of all by historical S&E degree production patterns. Age distributions for individuals with S&E degrees in 1997 are given by degree level and field of degree in appendix table 3-19. With the exception of new fields, such as computer sciences (where 70.0 percent of degree holders are under age 40), the greatest population density of individuals with S&E degrees occurs between ages 40 and 49. This can be seen in figure 3-12, which shows the age distribution of the S&E educated labor force broken down by level of degree. For all S&E degrees there is also a bump up in the age distribution at ages 25–29 representing 14.2 percent of S&E degree holders in the labor force. This bump up, however, appears to be largely caused by increased degree production in the social sciences (where 25- to 29-year-olds represent 17.7 percent of the total). In general, most of the S&E degreed labor force is their late 30s through early 50s.

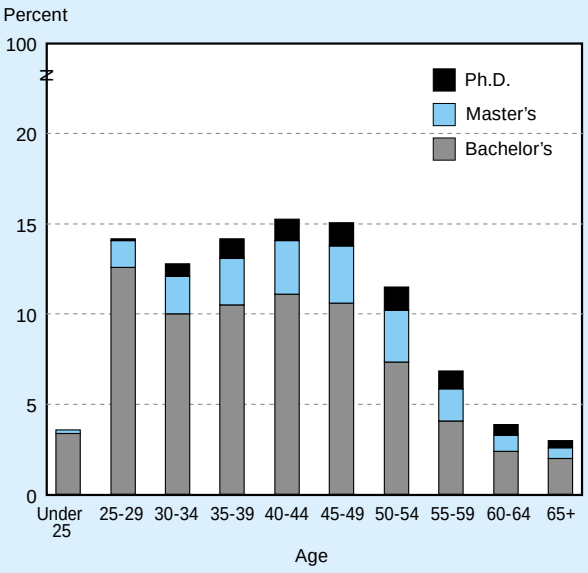
This general pattern holds true even for those with doctorates in S&E. Although Ph.D. holders are somewhat older than other S&E degree holders, this circumstance is because of fewer Ph.D. holders in the younger age categories, given the time needed to obtain this degree. The greatest population density of S&E Ph.D. holders in the labor force occurs for 45- to 54-year-olds.

S&E Ph.D. holders employed in tenured or tenure-track positions in four-year institutions of higher education (26.9 percent of all S&E Ph.D. holders) are somewhat older than all S&E Ph.D. holders—31.5 percent older than age 54 compared to 25.8 percent. (See figure 3-13.) The greatest population density of Ph.D. holders in these tenure programs occurs between ages 40 and 59. It is worth noting the sharp differences between the 55–59 and 60–64 age categories for both academic Ph.D. holders and the S&E Ph.D. population as a whole—a 48 percent drop that is much steeper than for the bachelor's or master's degreed S&E population.

At all degree levels and fields, only a small proportion of the S&E degreed labor force was near traditional retirement ages—only 13.6 percent overall were over age 54. This has several likely important and often overlooked effects on the future S&E labor force:

- Barring very large reductions in degree production or similarly large increases in retirement rates, the number of trained scientists and engineers in the labor force will continue to increase for some time. The number of individuals who are now receiving S&E degrees greatly exceeds the number of S&E degreed workers who are near traditional retirement ages.

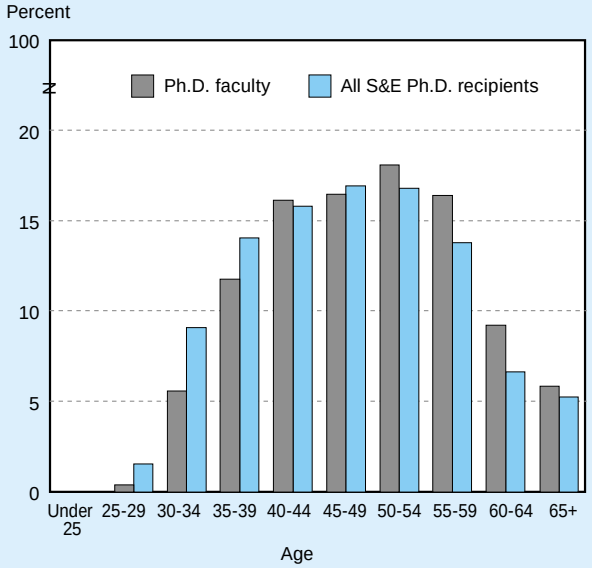
Figure 3-12.
Age distribution of labor force with S&E high degrees



Unpublished tabulations. *Science & Engineering Indicators – 2000*

[26]See Stephan and Levin (1992) and Posner (1995) for a discussion of the role of age for scientists and other creative workers.

Figure 3-13.
1997 age distribution of S&E Ph.D. recipients in the labor force: tenured and tenure-track faculty at four-year institutions



See appendix table 3-21. *Science & Engineering Indicators – 2000*

- Barring large increases in degree production, the average age of S&E degreed workers will rise.
- With current retirement patterns, the total number of retirements among S&E degreed workers will dramatically increase over the next 10–15 years. This may be particularly true for Ph.D. holders because of the steepness of their age profile.

Retirement

Retirement behavior can differ in complex ways from one individual to the next. Some individuals "retire" from a job while continuing to work full- or part-time, sometimes for the same employer. Others leave the labor force without a "retired" designation from some formal pension plan. Three different ways of thinking about changes in labor force involvement are summarized in text table 3-16 for S&E degree holders—leaving full-time employment, leaving the labor force, and retiring from a particular job.

By age 63, 50 percent of S&E bachelor's and master's degree holders were not working full-time. For S&E Ph.D. holders, this 50 percent mark is not reached until three years later, at age 66. Longevity also differs by degree level with other measures. Half of S&E degree holders have left the labor force entirely by age 64 for bachelor's degree holders, by age 65 for master's degree holders, and not until age 68 for Ph.D. holders. Formal retirement also occurs at somewhat higher ages for Ph.D. holders—more than 50 percent of S&E bachelor's and master's degree holder's have "retired" from some job by age 63, compared with age 65 for S&E Ph.D. holders.

Although many S&E degree holders who formally "retire" from one job continue to work full-time or part-time, this occurs most often among those under age 63. (See text table 3-17.) The drop in labor force participation among the "retired" is more pronounced for part-time work—older retired S&E workers are actually more likely to be working full-time than part-time. Retired Ph.D. scientists and engineers follow the same pattern, albeit with somewhat greater rates of post-retirement employment than bachelor's and master's degree holders.

Movement out of full-time employment by S&E degree holders aged 55–70 is shown in figure 3-14. At all degree levels, the proportion of S&E degree holders who work full-time declines fairly steadily by age. After age 55, full-time employment by S&E doctorates becomes significantly greater than for bachelor's and master's degree holders. At age 70, over 20 percent of S&E Ph.D. holders are working full-time, compared with 10 percent of bachelor's and master's.

Academic employment may be one reason for somewhat slower retirement among Ph.D. holders. Text table 3-18 looks at the rate at which S&E Ph.D. holders leave full-time em-

Text table 3-16.
Retirement ages for holders of S&E degrees

Highest degree	First age at which more than 50 percent are: Not working full-time	Not in labor force	Retired from any job
Bachelor's	63	64	63
Master's	63	65	63
Ph.D.	66	68	65

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), SESTAT data file, 1997.

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Text table 3-17.
Percentage of S&E degreed individuals who have "retired," but continue to work: 1997

Age group	Bachelor's		Master's		Ph.D.	
	Part-time	Full-time	Part-time	Full-time	Part-time	Full-time
50–55	52.1	15.8	65.1	17.3	62.1	20.4
56–62	27.2	13.4	35.7	13.7	36.8	18.5
63–70	9.1	12.7	8.7	15.6	13.9	17.6
> 70	4.0	8.4	5.1	9.6	5.4	10.9

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), SESTAT data file, 1997.

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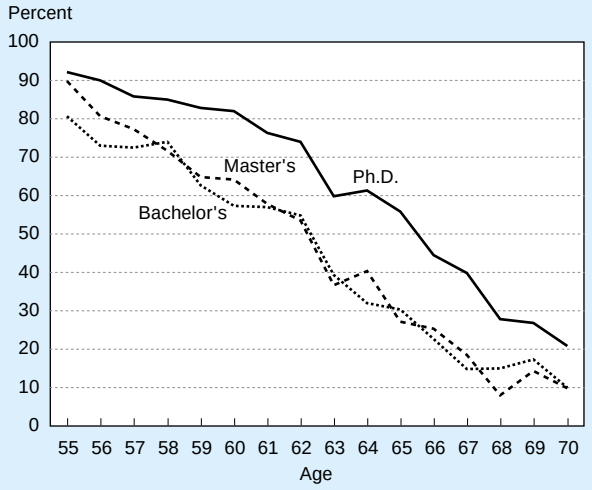
Figure 3-14.
Older S&E degree holders working full-time



See appendix table 3-22. *Science & Engineering Indicators – 2000*

Text table 3–18.
Percentage of 1995 S&E Ph.D.s leaving full-time employment by 1997: by sector of employment in 1995

Age in 1995	Four-year schools	For profit company	Govern-ment	All sectors
51–55	3.2	4.8	4.2	4.9
56–60	9.2	14.8	7.2	11.1
61–65	24.6	26.6	13.6	25.7
66–70	35.7	56.3	38.4	39.1
71–73	40.6	55.3	—	41.8

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), 1995 and 1997 Survey of Doctorate Recipients.

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ployment between 1995 and 1997 by sector of employment.[27] Within each age group, a smaller proportion of S&E Ph.D. holders employed in 1995 at four-year colleges and universities, or by the government, left full-time employment than S&E Ph.D. holders as a whole, or those employed by for-profit companies.

While slower retirement for S&E Ph.D. holders, particularly those in academia, is significant and of some policy interest, it is important to recognize that this does not mean that academic or other Ph.D. holders seldom retire. Indeed, figure 3-14 shows that their retirement patterns are much more like those of bachelor's and master's degree holders than they are different—retirement is just delayed two or three years. Even the two-year transition rates for academia in text table 3-18 shows more than a third of those aged 66–70 leaving full-time employment over a two-year period.

One reason academic Ph.D. retirement rates have been of interest has been a concern that the academic tenure system, combined with the end of mandatory retirement under U.S. antidiscrimination laws, could lead to continued employment of many less productive professors. Text table 3-19 compares two-year transition rates of leaving full-time employment for S&E Ph.D. holders employed full-time in 1995 at four-year institutions, by the number of articles they said they published within the previous five years. Within each age group, those writing six or more articles had a much lower transition rate out of full-time employment than those reporting fewer articles written. For those between the ages of 51 and 65, the transition rate for academics with zero articles was more than double the rate for those with six or more.

Projected Demand for S&E Workers

During the 1998–2008 period, employment in S&E occupations is expected to increase at almost four times the rate for all occupations. Though the economy as a whole is anticipated to provide approximately 14 percent more jobs over this decade, employment opportunities for S&E jobs are expected to increase by about 51 percent, or about 1.9 million jobs. (See text table 3-20.)

Approximately four-fifths of the increase in S&E jobs will occur in computer-related occupations. Overall employment in these occupations across all industries is expected to almost double over the 1998–2008 decade, with more than 1.5 million new jobs being added. Jobs for computer engineers and scientists are expected to increase from 914,000 to 1,858,000, while employment for computer systems analysts is expected to grow from 617,000 to almost 1.2 million jobs. (See the sidebar, "What Did Computer Workers Get Degrees In?")

Text table 3-19.
Percentage of 1995 S&E Ph.D. recipients at four-year institutions leaving full-time employment: by number of articles published in 1990–95

Age in 1995	No articles	1–5 articles	6 or more articles	All
51-55	5.7	3.5	1.0	3.2
56-60	12.2	8.6	6.7	9.2
61-65	32.6	23.5	16.1	24.6
66-70	—	43.1	28.0	35.7
71-73	—	—	28.1	40.6

— = Not available

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), 1995 and 1997 Survey of Doctorate Recipients.

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[27] As a practical matter, it would be difficult to calculate many of the measures of retirement used previously in this chapter by sector of employment. A two-year transition rate, however, can be calculated using the NSF/SRS SESTAT data file matched longitudinally at the individual level.